## REMARKS

In the Office communication, the examiner allowed claims 1-33 and 47-80, but objected to the listing of claims for failure to underline claims 47-80. Applicant interprets this formal requirement as referring to the Preliminary Amendment filed with the reissue application on March 11, 2004. Accordingly, Applicant submits herewith a corrected version of that earlier listing of the claims wherein all claims labeled *New* now have underlined text. Furthermore, Applicant submits a corrected version of the listing of claims submitted with Applicant's response to the Office Action mailed January 30, 2006. The formal corrections to this last listing of claims are confined to what Applicants believe is a more correct use of the status identifiers. With these formal requirements met, Applicant believes that claims 1-33 and 47-80 are in condition for allowance.

Respectfully submitted,

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**Certification under 37 CFR §§ 1.8(a) and 1.10**

I hereby certify that, on the date shown below, this application/correspondence attached hereto is being:

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## IN THE CLAIMS

This is a corrected version of the listing of claims submitted at the time the reissue application was filed.

**1.** *(Original)* A method for surface estimation of a resistivity depth image of a subsurface geologic formation, comprising the steps of:

determining the location of and at least one average earth resistivity for the vicinity of the subsurface geologic formation using geological and geophysical data from the vicinity of the subsurface geologic formation;

determining dimensions and probing frequency for an electromagnetic source to substantially maximize transmitted vertical and horizontal electric currents at the subsurface geologic formation using the location and the at least one average earth resistivity;

activating the electromagnetic source at or near the surface of the earth, approximately centered above the subsurface geologic formation;

measuring a plurality of components of electromagnetic response with a receiver array;

determining one or more geometrical and electrical parameter constraints, using the geological and geophysical data; and

processing the electromagnetic response using the geometrical and electrical parameter constraints to produce the resistivity depth image.

**2.** *(Original)* The method of claim **1**, further comprising the step of:

combining the resistivity depth image with the geological and geophysical data to estimate one or more properties of the subsurface geological formation.

**3.** *(Original)* The method of claim **1**, wherein the step of determining dimensions and probing frequency is accomplished by numerically solving the uninsulated buried low-frequency electromagnetic antenna problem.

**4.** *(Original)* The method of claim **1**, wherein the electromagnetic source comprises:

two continuously grounded circular electrodes positioned in concentric circles.

**5.** *(Original)* The method of claim **4**, wherein each circular electrode comprises one or more electrically uninsulated conductors.

**6.** *(Original)* The method of claim **4**, further comprising:

a third circular electrode positioned concentric with the two circular electrodes.

**7.** *(Original)* The method of claim **6**, wherein the third circular electrode comprises one or more electrically insulated conductors.

**8.** *(Original)* The method of claim **1**, wherein the electromagnetic source comprises six or more grounded linear radial electrodes of equal lengths placed along radii separated by equal angles, whose radial projections intersect at a common central point.

**9.** *(Original)* The method of claim **8**, wherein the radial electrodes are continuously grounded along their entire length.

**10.** *(Original)* The method of claim **8**, wherein the radial electrodes are continuously grounded only within a distance less than one half of the length of the radial electrode from each end.

**11.** *(Original)* The method of claim **1**, wherein the subsurface geologic formation is located onshore.

**12.** *(Original)* The method of claim **1**, wherein the subsurface geologic formation is located offshore and the surface of the earth is the seafloor.

**13.** *(Original)* The method of claim **1**, wherein the receiver array is positioned on a grid.

**14.** *(Original)* The method of claim **1**, wherein the receiver array is positioned as a linear array.

**15.** *(Original)* The method of claim **1**, wherein the receiver array is positioned as a swath array.

**16.** *(Original)* The method of claim **1**, wherein the step of processing the electromagnetic response further comprises:

verifying the at least one average earth resistivity using the plurality of components of electromagnetic response measured with the receiver array.

**17.** *(Original)* The method of claim **1**, wherein the step of processing the electromagnetic response further comprises:

applying 3-D wave-equation data processing to the electromagnetic response.

**18.** *(Original)* The method of claim **1**, wherein the step of processing the electromagnetic response further comprises data noise suppression, source deconvolution, and model-guided inversion.

**19.** *(Original)* The method of claim **7**, wherein the steps of activating the electromagnetic source and measuring the plurality of components of electromagnetic response further comprises:

measuring a first electromagnetic response without activating the electromagnetic source;

measuring a second electromagnetic response while activating only the third circular electrode; and

measuring a third electromagnetic response while activating only the two continuously grounded circular electrodes.

**20.** *(Original)* The method of claim **19**, wherein the step of processing the electromagnetic response further comprises:

merging the first and second electromagnetic responses to produce a fourth electromagnetic response;

inverting the fourth electromagnetic response; and

inverting jointly the third and fourth electromagnetic responses.

**21.** *(Original)* The method of claim **20**, wherein the step of processing the electromagnetic response further comprises at least one step chosen from:

inverting the first electromagnetic response;

inverting the second electromagnetic response; and

inverting the third electromagnetic response.

**22.** *(Original)* The method of claim **1**, wherein the resistivity depth image comprises at least one depth image component chosen from an inverted vertical resistivity depth image, an inverted horizontal resistivity depth image and an inverted three-dimensional resistivity depth image.

**23.** *(Original)* The method of claim **1**, wherein the dimensions and probing frequency are verified using iterated 3-D modeling.

**24.** *(Original)* The method of claim **8**, further comprising continuously grounded linear terminating electrodes connected substantially orthogonally at each end of the grounded radial electrodes.

**25.** *(Original)* The method of claim **24**, wherein the length of the terminating electrodes is less than or equal to one tenth of the length of the radial electrodes.

**26.** *(Original)* The method of claim **1**, wherein the electromagnetic source comprises a sub-optimal configuration.

**27.** *(Original)* The method of claim **11**, wherein the plurality of components of electromagnetic response comprise:

two orthogonal horizontal electric fields;

two orthogonal horizontal magnetic fields; and

a vertical magnetic field.

**28.** *(Original)* The method of claim **27**, wherein the plurality of components of electromagnetic response further comprises a vertical electric field.

**29.** *(Original)* The method of claim **12**, wherein the plurality of components of electromagnetic response comprise:

two orthogonal horizontal electric fields;

two orthogonal horizontal magnetic fields;

and a vertical electric field.

**30.** *(Original)* The method of claim **29**, wherein the plurality of components of electromagnetic response further comprise a vertical magnetic field.

**31.** *(Original)* A method for surface estimation of an inverted resistivity depth image of a subsurface geologic formation, comprising the steps of:

determining the location of and average earth resistivity above, below, and horizontally adjacent to the subsurface geologic formation using

geological and geophysical data from the vicinity of the subsurface geologic formation;

determining dimensions and probing frequency for an electromagnetic source to substantially maximize transmitted vertical and horizontal electric currents at the subsurface geologic formation using the location and the at least one average earth resistivity, said source comprising six or more grounded linear radial electrodes of equal lengths placed along radii separated by equal angles whose radial projections intersect at a common central point, continuously grounded linear terminating electrodes connected substantially orthogonally at each end of the grounded radial electrodes;

activating the electromagnetic source at or near the surface of the earth, approximately centered above the subsurface geologic formation;

measuring a plurality of components of electromagnetic response with a receiver array;

determining one or more geometrical and electrical parameter constraints, using the geological and geophysical data; and

processing the electromagnetic response using the geometrical and electrical parameter constraints to produce the inverted resistivity depth image.

**32.** *(Original)* A method for surface estimation of one or more properties of a subsurface geologic formation, comprising the steps of:

determining the location of and at least one average earth resistivity for the vicinity of the subsurface geologic formation using geological and geophysical data from the vicinity of the subsurface geologic formation;

determining dimensions and probing frequency for an electromagnetic source to substantially maximize transmitted vertical and horizontal electric currents at the subsurface geologic formation using the location and the at least one average earth resistivity, said source comprising six or more grounded linear radial electrodes of equal lengths placed along radii separated by equal angles whose radial projections intersect at a common central point;

activating the electromagnetic source at or near the surface of the earth, approximately centered above the subsurface geologic formation;

measuring a plurality of components of electromagnetic response with a receiver array;

determining one or more geometrical and electrical parameter constraints, using the geological and geophysical data;

processing the electromagnetic response using the geometrical and electrical parameter constraints to produce one or more inverted resistivity depth images of the subsurface geologic formation; and

combining the inverted resistivity depth images with the geological and geophysical data to estimate the properties.

**33.** *(Original)* A method for surface estimation of one or more properties of a subsurface geologic formation, comprising the steps of:

determining the location of and at least one average earth resistivity for the vicinity of the subsurface geologic formation;

determining dimensions and probing frequency for an electromagnetic source to substantially maximize transmitted vertical electric currents at the subsurface geologic formation using the location and the at least one average earth resistivity;

activating the electromagnetic source at or near the surface of the earth, approximately centered above the subsurface geologic formation;

measuring at least a vertical electromagnetic response with a receiver array;

determining one or more geometrical and electrical parameter constraints, using geological and geophysical data from the vicinity of the subsurface geologic formation;

processing the electromagnetic response using the geometrical and electrical parameter constraints to estimate the one or more properties.

**34.** *(New)* A method for designing a focused electromagnetic source for geophysical prospecting of a subsurface geologic formation comprising the steps of :

determining the location of and at least one average earth resistivity for the vicinity of the subsurface geologic formation using geological and geophysical data from the vicinity of the subsurface geologic formation; and

determining dimensions and probing frequency for said source to substantially maximize transmitted vertical and horizontal electric currents at the subsurface geologic formation using the location and the at least one average earth resistivity.

**35.** *(New)* The method of claim **34**, wherein the step of determining dimensions and probing frequency is accomplished by numerically solving the uninsulated buried low-frequency electromagnetic antenna problem.

**36.** *(New)* The method of claim **34**, wherein the dimensions and probing frequency are verified using iterated 3-D modeling.

**37.** *(New)* The method of claim **34**, wherein the electromagnetic source comprises two continuously grounded circular electrodes positioned in concentric circles.

38. *(New)* The method of claim **37**, wherein each circular electrode comprises one or more electrically uninsulated conductors.

39. *(New)* The method of claim **37**, further comprising a third circular electrode positioned concentric with the two circular electrodes.

40. *(New)* The method of claim **39**, wherein the third circular electrode comprises one or more electrically insulated conductors.

41. *(New)* The method of claim **34**, wherein the electromagnetic source comprises six or more grounded linear radial electrodes of equal lengths placed along radii separated by substantially equal angles, whose radial projections intersect at a common central point.

42. *(New)* The method of claim **41**, further comprising continuously grounded linear terminating electrodes connected substantially orthogonally at each end of the grounded radial electrodes.

43. *(New)* The method of claim **42**, wherein the length of the terminating electrodes is less than or equal to one-tenth of the length of the radial electrodes.

44. *(New)* The method of claim **41**, wherein the radial electrodes are continuously grounded along their entire length.

45. *(New)* The method of claim **41**, wherein the radial electrodes are continuously grounded only within a distance less than one half of the length of the radial electrode from each end.

46. *(New)* The method of claim **34**, wherein the electromagnetic source comprises a sub-optimal configuration.

47. *(New)* A method for surface estimation of a resistivity depth image of a subsurface geologic formation, said method comprising the steps of:

obtaining electromagnetic data, said data consisting of measurements previously made with a receiver array of a plurality of electromagnetic field components produced by a focused electromagnetic source located at or near the surface of the earth and approximately centered above the geologic formation, said focused electromagnetic source having been designed by determining the location of and at least one average earth resistivity for the vicinity of the subsurface geologic formation using geological and geophysical data from the vicinity of the subsurface geologic formation, and then determining dimensions and probing frequency for the electromagnetic source to substantially maximize transmitted vertical and horizontal electric currents at the subsurface geologic formation using the location of and the at least one average earth resistivity;

determining one or more geometrical and electrical parameter constraints, using geological and geophysical data from the vicinity of the subsurface geologic formation; and

processing the electromagnetic field measurements using the geometrical and electrical parameter constraints to produce the resistivity depth image.

**48.** *(New)* The method of claim **47**, wherein the subsurface geologic formation is located offshore, and the surface of the earth is the seafloor.

**49.** *(New)* The method of claim **48**, wherein the plurality of measured electromagnetic field components comprised two orthogonal horizontal electric fields, two orthogonal horizontal magnetic fields, and a vertical electric field.

**50.** *(New)* The method of claim **49**, wherein the plurality of measured electromagnetic field components further comprised a vertical magnetic field.

**51.** *(New)* The method of claim **47**, wherein the receiver array was positioned on a grid.

**52.** *(New)* The method of claim **47**, wherein the receiver array was positioned as a linear array.

**53.** *(New)* The method of claim **47**, wherein the receiver array was positioned as a swath array.

**54.** *(New)* The method of claim **47**, wherein the step of processing the electromagnetic field measurements further comprises verifying the at least one average earth resistivity using the plurality of electromagnetic field components measured with the receiver array.

**55.** *(New)* The method of claim **47**, wherein the step of processing the electromagnetic field measurements further comprises applying 3-D wave-equation data processing to the electromagnetic field measurements.

**56.** *(New)* The method of claim **47**, wherein the step of processing the electromagnetic field measurements further comprises data noise suppression, source deconvolution, and model-guided inversion.

**57.** *(New)* The method of claim **47**, wherein the resistivity depth image comprises at least one depth image component chosen from an inverted vertical resistivity depth image, an inverted horizontal resistivity depth image, and an inverted three-dimensional resistivity depth image.

**58.** *(New)* The method of claim **47**, wherein the subsurface geologic formation is located onshore, and the plurality of measured electromagnetic field components comprised two orthogonal horizontal electric fields, two orthogonal horizontal magnetic fields, and a vertical magnetic field

**59.** *(New)* The method of claim **58**, wherein the plurality of measured electromagnetic field components further comprised a vertical electric field.

**60.** *(New)* The method of claim **47**, wherein the electromagnetic source comprised two continuously grounded circular electrodes positioned in concentric

circles and a third concentric circular electrode, said third electrode having comprised one or more electrically insulated conductors and wherein the electromagnetic field component measurements comprised

measuring a first electromagnetic response without activating the electromagnetic source;

measuring a second electromagnetic response while activating only the third circular electrode; and

measuring a third electromagnetic response while activating only the two continuously grounded circular electrodes;

and wherein the processing step further comprises:

merging the first and second electromagnetic responses to produce a fourth electromagnetic response;

inverting the fourth electromagnetic response; and

inverting jointly the third and fourth electromagnetic responses.

**61.** *(New)* The method of claim **60**, wherein the step of processing the electromagnetic response further comprises at least one step chosen from:

inverting the first electromagnetic response;

inverting the second electromagnetic response; and

inverting the third electromagnetic response.

**62.** *(New)* A method for collecting electromagnetic data for resistivity depth imaging of a subsurface geologic formation using an electromagnetic source whose dimensions and probing frequency were determined to substantially maximize transmitted vertical and horizontal electric currents at the subsurface formation using a location of and at least one average earth resistivity for the vicinity of the formation,

said location and average resistivity having been determined from geological and geophysical data from the vicinity of the formation, said method comprising the steps of:

activating the electromagnetic source at or near the surface of the earth, approximately centered above the subsurface geologic formation; and

measuring a plurality of components of electromagnetic response with a receiver array.

**63.** *(New)* The method of claim **62**, wherein the dimension and probing frequency determination comprised a sub-optimal configuration.

**64.** *(New)* The method of claim **62**, wherein the electromagnetic source comprised two continuously grounded circular electrodes positioned in concentric circles.

**65.** *(New)* The method of claim **64**, wherein each circular electrode comprised one or more electrically uninsulated conductors.

**66.** *(New)* The method of claim **64**, wherein the electromagnetic source further comprised a third electrode positioned concentric with the two circular electrodes.

**67.** *(New)* The method of claim **66**, wherein the third circular electrode comprised one or more electrically insulated conductors.

**68.** *(New)* The method of claim **67**, further comprising the steps of:

measuring a first electromagnetic response without activating the electromagnetic source;

measuring a second electromagnetic response while activating only the third circular electrode; and

measuring a third electromagnetic response while activating only the two continuously grounded circular electrodes.

**69.** *(New)* The method of claim **62**, wherein the electromagnetic source comprised six or more grounded linear radial electrodes of equal length placed along radii separated by equal angles, whose radial projections intersect at a common central point.

**70.** *(New)* The method of claim **69**, wherein the radial electrodes were continuously grounded along their entire length.

**71.** *(New)* The method of claim **69**, wherein the radial electrodes were continuously grounded only within a distance less than one-half of the length of the radial electrode from each end.

**72.** *(New)* The method of claim **69**, wherein the electromagnetic source further comprised continuously grounded linear terminating electrodes connected substantially orthogonally at each end of the grounded radial electrodes.

**73.** *(New)* The method of claim **72**, wherein the length of the terminating electrodes was less than or equal to one-tenth of the length of the radial electrodes.

**74.** *(New)* The method of claim **62**, wherein the receiver array is positioned on a grid.

**75.** *(New)* The method of claim **62**, wherein the receiver array is positioned as a linear array.

**76.** *(New)* The method of claim **62**, wherein the receiver array is positioned as a swath array.

**77.** *(New)* The method of claim **62**, wherein the subsurface geologic formation is located onshore, and the plurality of components of electromagnetic response comprise:

two orthogonal horizontal electric fields;

two orthogonal horizontal magnetic fields; and

a vertical magnetic field.

**78.** *(New)* The method of claim **77**, wherein the plurality of components of electromagnetic response further comprise a vertical electric field.

**79.** *(New)* The method of claim **62**, wherein the subsurface geologic formation is located offshore and the surface of the earth is the seafloor, and wherein the plurality of components of electromagnetic response comprise:

two orthogonal horizontal electric fields;

two orthogonal horizontal magnetic fields; and

a vertical electric field.

**80.** *(New)* The method of claim **79**, wherein the plurality of components of electromagnetic response further comprise a vertical magnetic field.